EXPERIMENTAL DETERMINATION OF FUEL SULFUR EFFECTS ON OXIDATION AND LEAN-NO_x DIESEL ENGINE CATALYSTS

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Demand for reduction of oxides of nitrogen (NO_x) and particulate matter (PM) from diesel engines is surpassing the ability to control emissions through combustion improvement alone. When exhaust catalysts are considered for further emissions reduction, there is concern that sulfur in the fuel may mar the catalyst performance. The Diesel Emissions Control – Sulfur Effects (DECSE) program sought to quantify the impact of sulfur on emissions control devices. There was also interest in the extent to which the catalysts might increase the production of sulfate in the PM. West Virginia University conducted evaluations of lean-NO_x and diesel oxidation catalysts using both Cummins ISM370 and Navistar (International) T444E engines, representing high- and low-temperature exhaust, respectively. The lean NO_x catalyst was configured with upstream injection of diesel to facilitate the reduction reaction. To reduce the hours required for aging, the engine exhaust was split so that two catalysts could be aged simultaneously. Emissions characterization was also performed with a split exhaust system. The diesel fuels used had sulfur levels of 3 ppm, 30 ppm, 150 ppm and 350 ppm, and aging continued for up to 250 hours. The low-temperature, lean-NO_x catalysts showed an average 15 percent NO_x reduction efficiency over four steady-state modes. However, breakthrough of the diesel fuel reductant led to an increase in hydrocarbon emissions of 40 percent to 15 times. No clear effects on PM emissions were observed except after 250 hours of aging when the 350-ppm fuel was associated with more than a threefold PM emissions increase. The high-temperature catalysts had an average reduction efficiency of 11 percent for NO_x, with an increase in hydrocarbon emissions of 1-8.5 times. Fuel sulfur level did not adversely affect the NO_x reduction performance. PM emissions increased after 250 aging hours.